Our Case No. 7103/205 (P0707)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	
Li et al.	
Serial No. 09/938,056	Examiner: George Nguyen
Filing Date: August 23, 2001	Group Art Unit No.: 3723
For MULTI-STEP POLISHING SYSTEM AND PROCESS OF USING SAME	

DECLARATION UNDER 37 C.F.R. §1.131

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

The undersigned, Youlin J. Li, Stephen Jew, Sridharan Srivatsan, and K.Y. Ramanujam, hereby declare that:

1. We are the applicants of the above-identified patent application and co-inventors of the subject matter described and claimed therein.

2. Prior to December 4, 2000, a working version of the invention as described and claimed in the subject application was made in the U.S. (or in a NAFTA country prior to December 4, 2000 and on or after December 8, 1993) as evidenced by the following:

3. Attached as Exhibit A is a relevant portion of our Invention Disclosure Form (dates and certain sections of text have been redacted in the attached) created and witnessed prior to December 4, 2000 setting forth various aspects of our invention.

4. As shown in Exhibit A in the embodiment at, for example, pages 2-3, we describe how our invention for CMP teaches a multi-step process with an initial step of applying a first slurry and a subsequent step of applying a second slurry. The first slurry in the initial step is

without an oxidizer and the second slurry is similar to a standard slurry, which includes an oxidizer.

5. As shown in Exhibit A, page 3, we state that the invention was reduced to practice. The date of the reduction to practice of the invention, redacted in Exhibit A, is prior to December 4, 2000.

6. All statements made herein are of my own knowledge and are true and that all statements made on information and belief are believed to be true, and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States code, and that such willful statements may jeopardize the validity of the application or any patent issued therefrom.

Respectfully submitted,

Youlin J. Li	5/26/05 Date
Stephen Jew	Date
Sridharan Srivatsan	Date
K.Y. Ramanujam	Date

without an oxidizer and the second slurry is similar to a standard slurry, which includes an oxidizer.

5. As shown in Exhibit A, page 3, we state that the invention was reduced to practice. The date of the reduction to practice of the invention, redacted in Exhibit A, is prior to December 4, 2000.

6. All statements made herein are of my own knowledge and are true and that all statements made on information and belief are believed to be true, and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States code, and that such willful statements may jeopardize the validity of the application or any patent issued therefrom.

Respectfully submitted,

Youlin J. Li	Date
Stephen Jew	5/16/05 Date
Sridharan Srivatsan	Date
K.Y. Ramanujam	Date

without an oxidizer and the second slurry is similar to a standard slurry, which includes an oxidizer.

5. As shown in Exhibit A, page 3, we state that the invention was reduced to practice. The date of the reduction to practice of the invention, redacted in Exhibit A, is prior to December 4, 2000.

6. All statements made herein are of my own knowledge and are true and that all statements made on information and belief are believed to be true, and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States code, and that such willful statements may jeopardize the validity of the application or any patent issued therefrom.

Respectfully submitted,

Youlin J. Li	Date
Stephen Jew	Date
Srivatsan	04/28/05
Sridharan Srivatsan	Date
K.Y. Ramanujam	04/28/2005
K.Y. Ramanujam	Date

Invention Disclosure No: P0707

Name: Joseph Li

Date: 5/26/05

Current standard copper CMP processes utilize a multi-step, multi-slurry approach. The Lam Teres CMP system has been designed for maximum productivity with a copper CMP process. Bulk copper removal is performed on Linear Polishing Technology (LPT) Station 1. This quickly removes most of the copper overburden from the wafer and leaves a thin planar copper layer for the next processing step. LPT Station 2 is used to clear the remaining copper and leave a continuous barrier layer with minimal topography. A reliable, repeatable endpoint system with gentle process conditions is required by the second step. Finally, the Rotary Buff Module is used to completely remove the barrier and leave clean, corrosion free copper and oxide surfaces.

Due to the lack of an in-situ copper thickness monitor on the bulk copper removal step, it is important to have a stable, repeatable process so that a timed polish can be used which prepares a suitable surface for the endpoint and barrier removal steps. Bulk copper polishing removal rate stability is affected by a phenomenon known as pad loading. In standard oxide polishing, the removal rate stability is commonly affected by the polishing pad groove integrity. The removal rate stability tends to diminish as the grooves are worn down during the act of polishing and conditioning. In copper polishing, the rate stability is, however, often compromised far ahead of the degradation of the pad grooving. Visual inspection of the pad shows a dark brown or green staining of the pad as the removal rate stability degrades. The amount of staining on the pad is proportional to the amount of copper removed during the process.

The hypothesis for the pad loading issue is based in our understanding of the copper slurries. A copper slurry normally contains the abrasive, oxidizer, complexing agent and film forming agent. The purpose of an oxidizer (ie. H_2O_2) in the copper slurry is to change the state of abraded and unabraded copper material to copper oxides which will be complexed into the slurry solution by the complexing agent and swept away from the wafer surface. The issue is that many of the copper oxides along with copper film-forming agent (ie. BTA) tend to migrate to the polishing pad. This migration loads the polishing pad and effects the removal rate, uniformity and defectivity of the wafers over time. In-situ process changes (ie. conditioning, DIW rinsing) are usually ineffective in mitigating the loading effects. Some ex-situ techniques (ie. chemistry rinse, oxide dummies) may be somewhat effective, but fairly impractical in preventing or cleaning the pad loading.

This invention teaches a method to use a multi-step copper CMP processes, with a modified slurry for the initial step and the standard slurry for the bulk copper polish. The modified copper slurry contains only the abrasive, complexing agent, and film-forming agent, but without oxidizer (e.g. Cabot EP-C 5001). This "initiation" step would serve two purposes. The slurry would complex out the copper oxides that reside on the polishing pad surface and dissolve them into solution that is then discarded off the pad, and bring the pad surface back to a clean state. Also, the slurry would serve as a "break-through" step to remove the oxidized copper

surfaces, which usually slow down the Cu removal rate, that form through native growth and furnace annealing on the wafer surface. The use of the initiation slurry would then increase the copper removal rate since the native copper oxides grown on the surface are not present during bulk copper removal.

5. **Conception/Reduction/Commercial Use:**

Date of first conception:

Date of first notebook entry:

Where conceived?:

Was invention reduced to practice (made/used)? (yes/no): Yes
If yes, date first reduced: